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(54) A DEVICE FOR DETECTING FAULTS IN A TWO-WIRE LINE

(71) We, SOCIETE INDUSTRIELLE DE LIAISONS ELECTRIQUES of 64 bis Rue de Monceau, Paris 75, France, a body corporate organized according to the laws of France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a device for detecting an impedance variation in a line transmission system which is intended essentially, but not excusively, for the transmission of two-way telephone communications.

In many industrial installations, for example in mines, shipyards and other installations comprising handling and/or working eqipment located in positions or stations which are relatively distant from one another, it is desirable to employ a two-wire telephone circuit or telephone cable which affords an incident-signalling connection with a central station, these incidents resulting in short-circuits and/or breaks in the circuit or cable, which may be accidental or be caused manually (short-circuiting or circuit-breaking switches connected in the line and actuated by the operating personnel) or automatically (enviromental condition detectors, for example sensitive to excessive temperature rises, to critical atmosphere variations, etc., which are also connected in or associated with the said circuit or cable). At the central station, any detection of an incident of this nature sets off a local and/or remote alarm and if necessary results in the automatic remote performance of safety actions, for example, interruptions in the electric power supply through the equipment situated at intervals along the path of the circuit or cable.

It is an object of the present invention to provide an improved arrangement for detecting such faults in a telephone circuit or cable which forms part of an installation of the aforesaid type, the improvements being aimed at, above all, ensuring in a simple and reliable manner the positive safety of operation of this type of installation.

According to the present invention there is provided a device for detecting an impedance variation in a transmission line system which is terminated by its characteristic impedance and connected between two terminals, including circuit elements arranged as an impedance bridge of which the line system forms at least part of one arm, detecting means connected diagonally across the bridge for detecting imbalance of the bridge; two sets of electrical contacts operable by means of said detecting means; a trigger relay whose energizing winding is controlled directly or indirectly by means of the sets of contacts, and whose operation can trigger an alarm and/or safety devices associated with the line system; said detecting means causing respective one or other of the sets of contacts to change its state to operate the trigger relay so as to trigger the alarm and/or safety devices in dependence upon whether an increase or decrease of the impedance of the line system occurs.

A peak-limiting circuit may be connected in shunt across the terminals between which the line system is connected in order to limit the voltage across the terminals of the line to a safe value.

The arms of the bridge other than those which contain the line and the unbalance detector may be decoupled as regards alternating currents by means of capacitors in order to eliminate action of the ringing and bell alternating currents on the balance of the bridge.

The present invention will now be described in greater detail by way of examples with

reference to the accompanying drawing, wherein:—

Figure 1 illustrates one preferred form of device in which the balance detector of the bridge comprises electromechanical relays; and

Figure 2 illustrates another preferred form of device in which the balance detector of the bridge utilizes a combination of electronic controlled electrode elements and electromechanical relays.

In the figures, like elements are denoted by the same reference numerals.

In Figure 1, there is shown connected across terminals 14 a two-wire line terminated by its characteristic impedance 18. There may be connected along this line telephone stations, for example of the type having their own generators, of which two terminal boxes are shown at 19. In each tehminal box 19, there is indicated a push-button which short-circuits the line when depressed. A switch 20 is also provided for short-circuiting the line, which can be operated by pulling the operating lever either to the right or the left. A further normally closed switch 21 is provided in one of the lines for open circuiting the line either manually or automatically as hereinbefore stated. There may obviously be as many short-circuiting or open-circuiting switches as required. Moreover, accidental short-circuits or open-circuits are also taken into account. Whether a short-circuit or open-circuit results by accident or on purpose the response is the same.

In order to simplify the circuit of Figure 2, the arrangement of the line and its open-circuiting and short-circuiting members is not shown at the terminals 14.

In the two examples, there are shown two outgoing two-wire lines (one wire earthed) at 16 and 17. The feeding of these two lines is controlled by a relay R_1 which, when energized, applies thereto the alternating-current supply from the mains. When the line 16 is supplied with current, it sets off an acoustic and/or visual alarm signal at different locations of the installation with which the described system is concerned, for example at the central station and at various points along the path of the telephone line connected between the terminal 14. Electric contactors are associated with the line 17 so that when voltage is applied to the line, the contactors open to interrupt the feed to machines and equipment situated at various locations in the installation close to the telephone line.

The telephone line is introduced into one arm of a resistance bridge which is balanced when the line is neither short-circuited nor open-circuited. The arms of the bridge include the following components: a resistor 9, a resistor 11, a resistor 10 and a series circuit consisting of a resistor 12 and the telephone line whose resistance is that seen across the terminals 14. One diagonal of this bridge (the apex defined by the point of connection of the resistors 10 and 11 and the apex defined by the point of connection of the resistor 9 and of the series circuit) is supplied with direct current which has been rectified by a full-wave rectifier bridge 5 from the voltage across the terminals of a secondary winding 3 of a supply transformer 1. The transformer 1 has an earthed magnetic screen and its primary winding receives the voltage of the mains. The rectified voltage applied to the diagonal of the bridge has a value of the order of 20 volts. Connected across the terminals 14 are Zener diodes 13 which together with the resistor 12, effect the peak limiting of the voltage applied to the telephone line, or more precisely the limitation of the voltage across the terminals 14 of the line, to a value which is safe, namely to a value below 12 volts in the case of mine installations. Connected to the terminals of the rectifier on the direct-current side is a smoothing network comprising a capacitor 6 and a Zener diode 7, in shunt between the conductors extending to the apices of the diagonal of the bridge.

For a station-to-station call along the telephone line, the bell current or ringing generator current will of course reach the terminals 14 and the peak-limiting arrangement will also act to limit the amplitude of the peaks of the current, of alternating character, towards the balanced bridge. Moreover, in order to eliminate any untimely unbalancing action which might result from voltage variations at the terminals 14, due to such ringing, the resistor 10 is decoupled by a capacitor 35 of appropriate value and another decoupling capacitor 8 is connected to the terminals of the resistors 9 and 11, to be regarded as being in series for this decoupling effect.

The other diagonal of the bridge (apex consisting of the point of connection of the resistors 9 and 11 and apex consisting of the point of connection of the resistances 10 and 12) receives the arrangement for detecting the unbalance of the bridge.

In the arrangement of Figure 1, this detecting arrangement comprises essentially a relay R_o, the winding of which is connected in the diagonal of the bridge and the contact armature of which is polarized to have a neutral de-energized position, i.e. a position in which the contact armature is balanced between two contacts situated on either side and connected in common to one end of the winding of a relay R_2. This end of the winding is connected through a series resistor 32 to one pole of a rectifier bridge 4 fed by the secondary winding 2 of the transformer 1. The contact armature of the relay R_o is connected to the other end of the winding of the relay R_2, this winding being shunted by a resistor 31, so that this relay is normally energized as long as no short-circuit has been applied by means of

the contacts. The relay R_2 will become de-energized as soon as the resistor 31 is short-circuited by the contacts of the relay R_0.

The contact of the relay R_2 which is open when the relay is energized, is connected in the energization circuit of the relay R_1 which circuit extends from earth to a unidirectional-voltage source 15.

The operation of the arrangement will now be described in greater detail. As long as the line 14 is neither open nor short-circuited, the bridge remains balanced, and the relay R_0 is de-energized. The relay R_2 is energized and the relay R_1 also de-energized. If the line is broken, which results in a substantially infinite impedance at the terminals 14, the bridge is unbalanced in one sense and the relay R_0 is energized and attracts or repels its armature, depending upon the direction in which its winding is wound. The relay R_2 is de-energized, because owing to the short-circuiting of the resistor 31, the voltage across its terminals suddenly falls. The relay R_1 then becomes energized and closes the alarm and remote-control circuits 16 and 17. If the line is short-circuited, the operation is the same except for the direction of displacement of the armature of the relay R_0, since the unbalance of the bridge is then of opposite sense, and a very low impendance is substituted for the normal impedance of the line at the terminals 14.

In the arrangement of Fig. 2, the balance detector of the bridge comprises electronic relays for controlling two electromechanical relays, R_2^1 and R_2^2, whose contacts are in series with the supply of the relay R_1, between earth and the unidirectional-voltage source 15. For this purpose, the detector comprises a symmetrical arrangement of two transistors T_1 and T_2 and two controlled rectifier elements, of the type known as "dry thyratrons" or "thyristors" TH_1 and TH_2, whose control electrodes are connected respectively to the collector outputs of the transistors T_1 and T_2 and whose anode connection extend through the windings of the relays R_2. An alternating voltage is effectively applied by the secondary winding 2 of the transformer 1 across each of the thyristors TH_1 and TH_2. The base electrodes of the transistors T_1 and T_2 are connected respectively to the apices of the bridge which are defined by the points of connection of the resistors 9 and 11 on the one hand and of the resistors 10 and 12 on the other hand. The emitter electrodes of the transistors are biased at the same voltage by a common resistor 22 and a pair of equal voltage-distribution resistors 23 and 24. The collector electrodes of the transistors T_1 and T_2 are biased through series resistor networks 25—27 and 26—28 respectively. The control electrodes of the thyristors are connected to the intermediate points of the resistor networks 25—27 and 26—28 respectively through equal resistors 29 and 30.

The rectified voltage from the rectifier bridge 5 is fed through a protective series resistor 33 to form the voltage supply to the bridge.

This being so, as long as the bridge is balanced, the transistors T_1 and T_2 are non-conductive and the two thyristors TH_1 and TH_2 are conductive, so that the relays R_2^1 and R_2^2 are energized. The normally open contacts of these relays therefore close the energization circuit of the relay R_1 which, when operated, opens at its contacts the alarm and remote-control circuits 16 and 17.

As soon as an unbalance occurs, either due to a short-circuit or due to a break in the telephone line, one of the transistors T_1 and T_2, depending upon whether there is a short-circuit or a break in the telephone line, is rendered conductive, and the corresponding thyristor is rendered non-conductive, so that that one of the relays R_2 which is situated in the anode circuit of the blocked thyristor becomes de-energized. The contact of this relay R_2 opens, thus breaking the circuit for holding the relay R_1 in the energized position, so that the latter drops out and closes the alarm and remote control circuits.

WHAT WE CLAIM IS:—

1. A device for detecting an impedance variation in a transmission line system which is terminated by its characteristic impedance and connected between two terminals, including circuit elements arranged as an impedance bridge of which the line system forms at least part of one arm; detecting means connected diagonally across the bridge for detecting imbalance of the bridge; two sets of electrical contacts operable by means of said detecting means; a trigger relay whose energizing winding is controlled directly or indirectly by means of the sets of contacts, and whose operation can trigger an alarm and/or safety devices associated with the line system; said detecting means causing respective one or other of the sets of contacts to change its state to operate the trigger relay so as to trigger the alarm and/or safety devices in dependance upon whether an increase or decrease of the impedance of the line system occurs.

2. A device according to claim 1, including a voltage peak-limiting circuit part of which is connected in shunt across the terminals between which the line system is connected, so as to limit the maximum voltage which can be supplied to the line system.

3. A device according to claim 2, wherein the voltage peak-limiting circuit includes zener diodes.

4. A device according to any one of the preceding claims, wherein the arms of the bridge other than those which contain the

line system are decoupled as regards alternating currents, by means of capacitors in order to eliminate action of alternating currents in the line system on the balance of the bridge.

5. A device according to any one of the preceding claims, wherein the detecting means includes a first electromechanical relay for making or breaking one or other of said two sets of contacts and having its armature biased to a neutral position when the bridge is balanced.

6. A device according to claim 5, wherein the trigger relay is a second normally energized relay which has a resistor and the two sets of electrical contacts both connected in shunt therewith, whereby when said first relay is energized on unbalance being detected, said second relay becomes de-energized due to the short-circuiting action of one of said two sets of electrical contacts.

7. A device according to any one of claims 1 to 4 wherein the detecting means is transistorised.

8. A device according to any one of the preceding claims 1 to 4, wherein the detecting means includes a balance arrangement of thyristors, of which the output circuits include therein the windings of electromechanical relays, one thyristor effecting the actuation of the alarm and/or safety devices at unbalance of the bridge in a first sense, and the other thyristor effecting the actuation of the alarm and/or safety devices at unbalance of the bridge in the opposite sense to the first sense.

9. A device for detecting an impedance variation in a line system connected between two terminals constructed substantially as herein described with reference to and as illustrated in Figure 1 or Figure 2 of the accompanying drawing.

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1250766 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

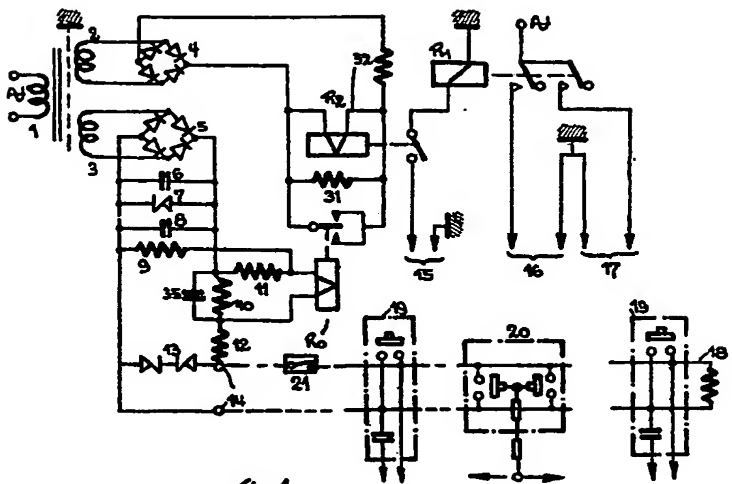

Fig.1

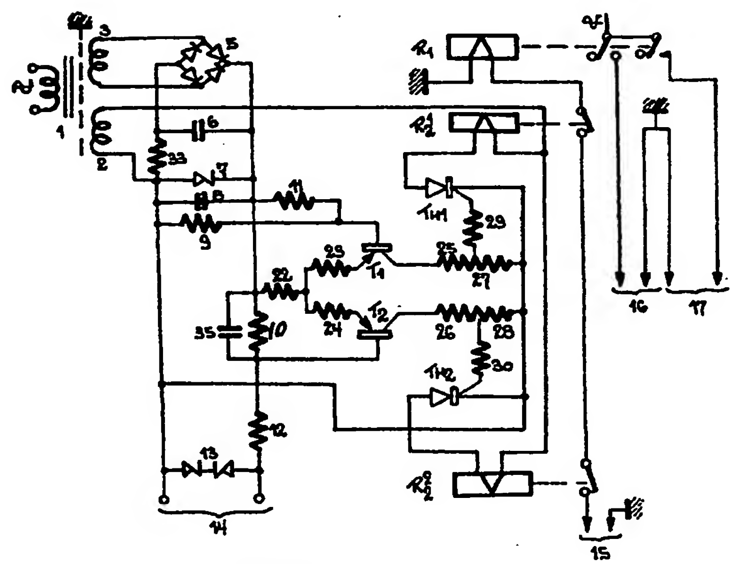

Fig 2

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